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XX.—*On the Primary Origin of the Sexual Products.*
By M. HERMANN FOL*.

A MEMOIR of great importance from the point of view of embryogenic morphology appeared at the end of last year†. This memoir is the fruit of the investigations made by E. van Beneden on the mode of formation of the testis and ovary in *Hydractinia echinata* and *Clava squamata*.

The *Hydractinia* is particularly well adapted for this investigation, because its colonies are male or female; each colony contains individuals in different stages of development, the sex of which is thus known beforehand. To this we must add the simplicity of organization of the Cœlenterata, especially the Hydroida, which consist during the whole of their life principally of the two primitive lamellæ, the ectoderm and entoderm—the mesoderm, represented by muscular fibres and connective tissue, being very little developed. The results of researches made upon an object so favourable must have an almost absolute certainty, and deserve our full confidence.

Van Beneden saw the testis form at the expense of a mass

* Translated by W. S. Dallas, F.L.S., from the 'Bibliothèque Universelle, Archives des Sciences Physiques et Naturelles,' June 15, 1875, pp. 104-111.

† E. van Beneden, "De la distinction originelle du testicule et de l'ovaire; caractère sexuel des deux feuilletts primordiaux de l'embryon; hermaphrodisme morphologique de toute individualité animale &c.," Bull. Acad. Roy. de Belgique, 3^e sér. tome xxxvii. 1874.

of cells, which results from a hollow or solid invagination of the outer lamella. The ova, on the contrary, descend directly from a certain number of cells of the entoderm. The two organs are sketched out in each of the two sexes; but the testis is atrophied afterwards in the reproductive individuals of the female colonies and the ovary in those of the male colonies.

Waldeyer had previously found that the superficial epithelium of the ovary of certain Vertebrata is derived from the peritoneal epithelium which covers the middle lamella, which itself appears to be a dependency of the entoderm. The testis is formed at the expense of the Wolfian canal, which appears to be derived from the ectoderm.

Bringing together his own and these latter results, Van Beneden sees in them a confirmation of his ideas, and considers it probable that they will be verified for the animal kingdom in general. It will be admitted that it is going rather quickly to conclude the universality of these phenomena throughout the animal kingdom from two observations so isolated, and only one of which, founded upon the investigation of *two species* of Hydroid polypes, presents the character of scientific certainty!

These conclusions must certainly have appeared very bold, to say no more of them, to many readers. Indeed we know that none of the authors who have paid attention to the primary origin of the sexual products in various sections of the animal kingdom, with the exception of the Vertebrata, have observed any facts which could be in accordance with these views. Their generality is so far from being demonstrated, that even among the Cœlenterata there are some of which the sexual products appear to be formed at the expense of the entoderm alone. Häckel is explicit upon this point with regard to the Geryonidæ. In *Cordylophora* and in *Hydra* the sexual products are derived from the ectoderm, according to the careful researches of F. E. Schultze and Kleinenberg. Moreover are not the results of the recent investigations in embryogeny of a nature to inspire us with prudential feelings? Have not very great and quite unexpected differences in the mode of formation of the lamellæ and organs been observed even in allied genera?

Hence it was with absolute scepticism that I, for my part, received M. van Beneden's generalizations. Without throwing the least doubt in the world upon the result of his researches upon two species of Hydroid polypes, I could not admit as probable that this mode of development of the organs of generation was universal, or even very widely diffused. All that I

could recall to mind of my own observations upon the Ctenophora, the Geryonidæ, and the Mollusca was in favour of Hæckel's ideas; and in the Pteropoda especially I had clearly seen what I took to be the entire genital gland formed by a scission of part of the inner lamella. These observations on the Pteropoda are recorded in a memoir which will appear immediately.

Nevertheless the perusal of M. van Beneden's memoir and certain contradictions to be met with in those authors who have paid attention to this subject for the Mollusca, made me wish for an opportunity of verifying afresh the correctness of my opinions. Thus it is well known that most authors represent the hermaphroditic gland of the Mollusca as originating from the posterior part of the liver—that is to say, from the entoderm. My own observations were in support of this view, as I had seen the gland in question separate by scission from the wall of the nutritive sac in the Pteropoda. Now the nutritive sac gives direct origin to the liver in many Cephalophora, although this is not the case in the Pteropoda.

But one author, whose opinion weighs heavily in the balance, did not share this opinion. J. Müller describes the genital organs in *Creseis* as originating from a pyriform organ which is suspended by the side of the stomach and the origin of the nutritive sac. What is the origin of this organ? and what are the modifications it undergoes in order to give origin to the sexual organs? The observations of the great anatomist give no answer to these questions.

Being at Messina during the months of February and March in the present year, my first care was to resume the question *ab ovo*. Chance was in my favour; the larvæ and young of *Creseis* abounded in the sea at a depth of from 5 to 10 fathoms.

I had no trouble in finding the pyriform body described by J. Müller in young animals which had recently undergone metamorphosis. It was moreover already indicated in some of my previous drawings. A careful study of its structure and relations showed me that it was composed of a great number of not very distinct small cells, and connected with the ectoderm by sarcode prolongations of its substance. The largest of these prolongations was attached to the ectoderm in the region near the anus, and to the anus itself, by means of a quantity of branched filaments of extreme tenuity. The other sarcode processes were attached to the portion of the ectoderm that surrounds the branchial or pallial cavity.

This body, which is situated, as well described by J. Müller, on the left side of the stomach, afterwards takes on a very

rapid development; it is this circumstance that previously prevented my recognizing it in the organ of large dimensions which it has become in individuals but little larger than the preceding ones. It then presents the form of a thick elongated body, lobulated on its surface, and surrounding the base of the nutritive sac like a half-cylinder. The spermatozoids speedily form in the lobules of this organ; it is the testis.

It remained to discover the primary origin of the pyriform body of J. Müller. The youngest larvæ of *Creseis* that I met with already possessed it. It was globular and very small, composed of a few cells, and situated near the anus. Sarcodic filaments attached it to the anus and the neighbouring part of the ectoderm. It is well known that most of the larvæ of the Cephalophora possess by the side of the anus two cellular masses which project into the cavity of the body, and originate by proliferation from the ectoderm of the anal region. One of these cellular bodies gives origin to the kidney. The other some authors regard as the origin of the genital organs—an opinion which is not founded upon any positive observation, but only on the fact that they did not know what other signification to attribute to it. This cellular body is no doubt the origin of the pyriform body, which is nothing but the rudiment of the testis. The testis, therefore, originates from the ectoderm.

The ovary is formed in the manner that I have described in my memoir on the Pteropoda. The only error into which I have fallen with regard to it has been that I have taken the rudiment of the ovary for the origin of the entire hermaphroditic gland. Each of the brownish cells, a single layer of which composes the wall of the nutritive sac, divides crosswise into an exterior transparent cell and an interior brown cell. This scission takes place only on the right side of the sac. The inner layer of brown cells continues to form the epithelium of the nutritive sac, whilst the exterior layer envelops it in the form of a half-cylinder. The cells of the latter layer multiply slowly, then begin to enlarge; and each of them becomes an ovule. But these ovules do not attain their maturity until after the more or less complete evacuation of the semen accumulated in the testis.

I have ascertained the same facts in an orthoconchal Pteropod, *Styliola subulata*.

In *Creseis* the male and female parts of the hermaphroditic gland are simply applied to each other throughout their length, and their contact does not become intimate until after the absorption of the nutritive sac. But the ovary and the testis do not mingle so intimately as in the other Cephalophora;

it was therefore an interesting matter to ascertain whether things went on in the same way in the latter. Unfortunately all the Gasteropoda that I had at my disposal became very opaque at the close of the larval period, and time did not allow me to commence a series of researches upon this point by means of dissections. I was obliged to content myself with ascertaining that the same mode of development occurs in a Heteropod with distinct sexes, the larvæ and young of which were frequently met with, namely *Atlanta Peronii*.

It is therefore admissible that even those of the Cephalophora which have distinct sexes are originally hermaphrodite. However, as my investigations relate only to a single genus, it would be premature to pronounce an opinion upon this point. Even as regards *Atlanta*, in order to be sure that the two sexes are originally identical, it would be necessary to have proof that some of the young animals that I observed were destined to become males and others females; and this proof is wanting.

At any rate the formation of the male sexual products at the expense of the ectoderm, and of the female products at the expense of the entoderm, is ascertained positively in three genera of Cephalophora, belonging to two different orders of that class.

In the *Appendiculariæ* I have been unable to follow the primary formation of the sexual organs. But in very young individuals of the genus *Fritillaria* the ovary was found to be applied against the digestive tube, whilst the testis was contiguous to the posterior extremity of the body. Subsequently these two organs came into contact with each other, but without becoming united. However, I only give these facts as a simple indication; they are too incomplete to prove any thing.

This confirmation of Van Beneden's views is the more striking, as I was so sceptical when I commenced the examination of the question, and especially because the Cephalophora, with their sexual products intimately mixed in their hermaphroditic gland, are precisely the animals in which *à priori* we should least expect to see these views confirmed.

The primary origin of the testis and the ovary in the two primitive lamellæ of the embryo is now ascertained positively in cases taken from two great divisions of the animal kingdom, the Cœlenterata and the Mollusca; it is rendered very probable by examples taken from the two divisions of the section of the Chordata—namely, the Tunicata and the Vertebrata.

The question whether this fact of prime importance is general for all animals has made another step towards its solution. Nevertheless, for the present I shall abstain from sharing the assurance with which Van Beneden deduced his generalization. But whether this mode of formation is universal, or only of very general occurrence, the able Belgian observer will always have the merit of having not only discovered the fact, but grasped its whole bearing. Observations so important and so valuable to science may well lead us to pardon bold theories. Would that all who launch imperfectly founded hypotheses under the pompous title of theories had so good an excuse!

XXI.—*Note on Entomostraca from Kerguelen's Land and the South Indian Ocean.* By GEORGE STEWARDSON BRADY, C.M.Z.S., Professor of Natural History in the College of Physical Science, Newcastle-on-Tyne.

Two gatherings of Entomostraca, belonging to the order Copepoda, have been submitted to me for examination by the Rev. A. E. Eaton. One gathering, from a lake which must, in all probability, have been brackish from communication at infrequent intervals (possibly at very high tides only) with the sea, contained only *Harpacticus fulvus*, Fischer, a species very commonly distributed over Europe in pools at or above high-water mark. The other gathering was made by the towing-net in the open sea, and contained likewise only one species, apparently undescribed and belonging to the genus *Centropages*, Kröyer. Females only were taken.

Centropages brevicaudatus, nov. sp.

Length $\frac{1}{10}$ of an inch. Upper antennæ equal in length to the first two cephalothoracic segments, 25-jointed, shortly setose, and tapering slightly to the distal extremity. Swimming-feet having both branches 3-jointed, inner branch short; first pair much shorter than the three following; outer branch of the fifth pair having its second joint produced internally into a strong denticulated spine; marginal setæ of both branches extremely short. Abdomen short; caudal setæ short, plumose, subequal, length equal to half that of the abdomen.

Hab. Lat. 33° 13' S., long. 37° 37' E.